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TRAINING MANUAL

INTEGRATED PEST MANAGEMENT

FOR GRAPES FARMERS



The Agribusiness Project – Agribusiness Support Fund

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Integrated Pest Management Training Manual for Grapes Farmers – The Agribusiness Project

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This manual is a live document which can be changed as the project progresses. Any suggestions for further improvement are most welcome. Project staff is particularly encouraged to identify areas for further improvement.

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INTEGRATED PEST MANAGEMENT (IPM)

Agriculture sector is putting enormous burden on the environment in the process of providing food and fiber to humanity. Plant protection is absolutely essential for efficient and maximum crop production as pest damages are unbearable. There are many methods to manage insect pests. These are chemical, biological, physical/mechanical, cultural, genetically, radiation etc., but chemical is widely practiced. Pesticides have been called ecological narcotics. Their effect of suppressing problems is temporary and cause addiction to their continuous use. Insect pests destroy about 20-25% of our crops before and after harvest. The pesticides, because of their quick action, seem to be the best answer to the problem but detrimental effects with the use of pesticides in the shape of hazards to human beings, animals, plant and environment have prompted greater interest in Integrated pest management of insect pests.

WHAT IS IPM?

Integrated Pest Management (IPM) is the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property and the environment.

PRICIPLES OF IPM

- The most efficacy use of natural control factors.
- Other means may integrate with natural control factors if pests are potentially increase.
- Avoid harmful methods to non target fauna.
- Pest can exist at tolerable level in order to maintain natural enemies.
- Equilibrium of ecosystem is target for management.

BASIC UNDERSTANINGD FOR IPM

Farmers who practice IPM have to understand related natural factors interacting with plants and how to integrate artificial methods with existing control factors. Therefore, their understanding should be focused on:

- Ecosystem
- Natural Control
- Supporting and inhibiting factors of plant production
- Integrated pest management
 - Tools of IPM
 - Strategy for IPM

ECOSYSTEM

WHAT IS Ecosystem?

“The relation of plants and living creatures interacting with each other and with their surroundings, especially in a self - sustaining way.”

Living organisms which exist in ecosystem are identified into specific groups depending on their habits and behaviors of consuming and being consumed as follows:

- Plants - primary producers
- Herbivores - primary consumers
- Carnivores - secondary or may be tertiary consumers
- Decomposers
- Scavengers

NATURAL CONTROL

“The maintenance of population numbers within certain upper and lower limits by the action of whole environment.”

Natural control is a phenomenon of “balance of nature”.

NATURAL FACTORS FOR PEST REGULATION

- Biotic factors
 - Natural enemies
 - Tolerant plants
- Physical factors
 - Climatic factors
 - Temperature, humidity, rain, cold, drought and sunlight
- Geographic factors
 - High or low land, barriers and soil texture

TOOLS FOR IPM

- MONITORING
- NATURAL CONTROL
 - BIOTIC FACTORS
 - PHYSICAL FACTORS
- BIOLOGICAL CONTROL

- CULTURAL CONTROL
- MECHANICAL CONTROL
- PHYSICAL CONTROL
- BOTANICAL CONTROL
- CHEMICAL CONTROL
- APPLICATION TECHNIQUE

MONITORING

Plant, pests and natural enemies are biotic factors which relate in feeding series in food chain. Therefore, the population dynamic of each one will depend on their hosts or prey in the surrounding. In normal surrounding the population of plants, pests and natural enemies will increase or reduce synchronize together and be in a constant equilibrium. But in unmoral climatic conditions and surroundings the amount in increase or reduction of these three factors might not be synchronized e.g. pests increase due to abundance of plants but natural enemies decline. This situation causes imbalance between pests and natural enemies and pest outbreaks might occur. Therefore, growers have to monitor pests, natural enemies and damaged plant parts regularly in order to make correct decision for pest control and can find out appropriate control measures to the situation.

HOW TO MONITORING

- Regularly survey and scout pests, natural enemies and damaged plant parts.
- Collect climatic data.
- Assess the effectiveness of natural enemies in controlling pests.
- Analyze pest situation.

BIOLOGICAL CONTROL

“The action of parasites, predators and pathogens in maintaining another organism’s density at a lower average than would occur in their absence”

- Biological control of pests is a natural phenomenon concerning with the regulation of plant pest numbers by their natural enemies.

Biological control of pests can be divided up to the purposes of using into 3 types:

- Natural biological control
- Augmentative biological control
- Classical biological control

NATURAL BIOLOGICAL CONTROL

The action of parasites, predators and pathogens in suppressing pest density to a certain level which will not damage plant.

- Natural biological control is an important factor of natural control that keep pests in a state of balance with their environment, and it is the only sustainable method of pest control.

EXAMPLES:

- Coccinellids feeds on mealy bug
- Bird feeds on larvae
- Spiders feed on various insects
- Aphid parasitized by *Aphidius*
- Larvae infested by fungus

These parasites, predators and pathogens are the natural enemies of pests which help suppressing the population of pests regularly. Only natural enemies are the friends of farmers.

AUGMENTATIVE BIOLOGICAL CONTROL

The use of parasites, predators and pathogens to suppress pest population. Various species of parasites, predators and pathogens can be mass reared or propagated in great numbers and released in situation where pests are not in kept at low level.

EXAMPLES:

- *Tricogramma* against lepidopterous insect pest.
- *Encarsia* against whitefly.

These augmented natural enemies will help naturally occurring natural enemies suppressing pest population effectively and more rapidly.

CLASSICAL BIOLOGICAL CONTROL

The introduction of natural enemies from the original sources to other sources where there are (original) pest outbreaks.

WHY TO USE CLASSICAL BIOLOGICAL CONTROL

In commercial plantings, plants will be moved from original source to other place or from one country to other countries. In some cases, pests are attached to plant without their natural enemies and cause pest outbreaks in the new area. Therefore, the exotic natural enemies from

the original source have to be searched and introduces to the new plantation in order to control the exotic pest.

CONSERVATION OF NATURAL ENEMIES

Protection and encouragement of natural enemies:

- This is the most important step in biological control and must be conducted by farmers. Good care of natural enemies will enhance their population naturally and increase their efficiency to suppress pest population.
- Natural enemies are natural resources and real friend of growers for pest control and it is the only sustainable control methods.

HOW TO CONSERVE NATURAL ENEMIES

CONSERVATION METHODS:

- Keep small plants and grasses at certain spot to provide pollen and nectar in the field to be food sources and niches for parasites and predators.
- Increase moisture during dry season by spraying water in the field in order to enhance the survival of natural enemies.
- Provide artificial habitats of hidden places for parasites and predators while chemical control is operated.
- Reduce pests by un harmful methods such as:
 - Biological control
 - Cultural control
 - Mechanical control
 - Physical control
 - Botanical control
- When chemical control has been chosen, careful and correct practices have to be observed:
 - Use selective pesticides.
 - Select low harmful pesticide to natural enemies.
 - Spot spray only.

BENEFITS FROM CONSERVATION OF NATURAL ENEMIES

- Natural enhancement of natural enemies.
- Increase effectiveness of pest suppression.
- Reduce production cost.

MASS PRODUCTION OF NATURAL ENEMIES

“Produce great numbers of parasites and predators by mass rearing or mass production.”

HOW TO PRODUCE EFFECTIVE NATURAL ENEMIES IN GREAT NUMBERS

- Select healthy and vigorous parents of parasites or predators for mating for production.
- Use artificial diet in mass production in order to many generations which will save time, labor and cost.
- Change parent stock after 3-4 generations of production.
- Rear in control room at appropriate temperature and humidity for the fecundity, growth and longevity of each species.
- Always keep equipment and rearing rooms clean.
- Avoid the contamination by other insects, diseases or small living creatures.
- Produces have to pay well attention regularly.

AUGMENTATION OF NATURAL ENEMIES

- Introduce specific parasitoid and predator species to release in the field.
- Rate of release depend on the ability of parasitization or predation of each species.
- Investigation the survival and enhancement of natural enemies after release.

EVALUATION

Examine the result of biological control of both naturally occurring control and control by augmentation.

EVALUATION METHODS

- Regularly survey and scout the population of natural enemies, pests and damage plants parts by sampling methods in fields in which natural enemies were released and in control fields.
- Collect datas and analyze.
- Assess the effectiveness of natural enemies in parasitism or predation.
- Compare the results between field in which natural enemies were released and control fields.

HOW TO ASSESS THE ROLE OF NATURAL ENEMIES?

- Count number of predators, parasites or pathogen and living pest in sampling site
 - Predators: count number of predators and remaining living pest.
 - Parasites: count number of parasitized insect pest and healthy pests.

- Analyze data every week after surveying and scouting. Then the percentage of predation and parasitization can be found out.

BENEFITS OF EVALUATION

Farmers need information in order to improve biological control more effectively in their own field/orchards, concerning with

- Natural species and their effectiveness.
- What parasitoid and predator species are needed for release?
- Optimum time and rate of released natural enemies.
- The ability of survival and enhancement after release in new surroundings.
- Effectiveness of suppressing pest after release.

CULTURAL CONTROL

To make unsuitable conditions for the survival of pests e.g.,

- Soil improvement
- Resistant varieties
- Wide spacing
- Pruning and thinning
- Water management
- Plants barriers
- Early or late planting and harvesting
- Crop rotation
- Intercropping
- Keep same plants on the orchard
- Collect damaged plant parts and burn
- Cutting weeds

MECHANICAL CONTROL

Reduction of pests by man or equipment e.g.,

- Hand collection and destruction
- Sticky trap
- Water jet spray
- Wrapping or protecting with some materials
- Sucking or collection machines

PHYSICAL CONTROL

The reduction of pests by using physical and energy factors e.g.,

- Light trap
- Humidity
- Heat
- Cold
- Sound

BOTANICAL CONTROL

The reduction of pests by using plant substances which can repel inhibit feeding, inhibit moulting and kill insect pests.

CHEMICAL CONTROL

The reduction of pest by using synthetic chemicals

- Insecticides
- Fungicides
- Acaricides
- Herbicides
- Insect growth regulators
- Attractant repellants

HOW TO USE CHEMICALS

- Chose selective chemicals
- Spray only in the area where pest ETL reach
- Understand application technique
- The application have to protect themselves while spraying

INSECT PESTS OF GRAPES

Hawk Moth



Eggs are laid singly or in batch of 10- 20 on the under surface of leaf which hatch in 6-7 days. The larvae are full grown in 30-40 days. Pupal period varies from 18-25 days in summer .The pest passes through 2 generation in year.

Nature of Damage

Breeding activity begins in April when the moths emerge from the over wintering pupae in June- July, the activity of the second brood begins and continues till September. The caterpillar are voracious feeder of grape- vines leaves. It has been estimated that one caterpillar eat from 10- 20 leaves per day.

Management

Hand picking of the caterpillars is very effective in case of minor infestation. Use of light traps for adults during night will also suppress the population. In case of severe infestation spray with Bifenthrin @ 250 ml/acre.

Grape- Vine Leaf-Roller



The moth laid 98-128 eggs, singly on the underside of the leaf which hatch in 2-3 days. The pupation takes place inside the leaf roll. Later on, the pupa falls on the ground and get underneath the fallen leaves and debris .The pest passes through 2-3 overlapping generation in a year.

Nature of Damage

The pest remains active from August-October. Only the caterpillars cause damage, the young caterpillars feed gregariously on the lower epidermis of leaves. The grown up larvae roll up the leaves margins towards the midrib, their being one larva in each roll.

Management

Hand picking of the caterpillars is very effective in case of minor infestation. Use of light traps for adults during night will also suppress the population in case of severe infestation spray with Bifenthrin @ 250 ml/acre.

Grape- Vines Beetle



The life cycle varies wide limits: its minimum may be about 3 months and the maximum being over 4 years. The insect emerges as adult beetle throughout the year.

Nature of Damage

The pest is active on dormant vine. After winter sets in, the adult bore into the living woody stems and branches. The multiplication of the pest continues in the dead vine throughout the year. The adult beetle constructs a circular hole, extending to the centre of the stem and then makes longitudinal galleries and form a number of exists. Both the adult and grubs cause damage by feeding inside the vine stems. All the plant parts above the point of attack dry up completely.

Management

Pruning and destroying infested parts

Removing loose bark and avoiding bamboo sports in the vineyard discourages the population growth of beetle

Application of Bifenthrin @ 250 ml/acre.

Grape-vine girdler



In the spring, the adults become active at night when they mate. The grubs hatch in about 7-10 days and bore tunnels directly into the wood. Pupation occurs in the elongate chamber and the adults escape by cutting the circular exit holes. Emergence mostly occurs during the months of July-August.

Nature of Damage

Damage is done both by the adults and the grubs. Girdling of the green branching is an essential event before egg laying. The vines dry up above the point of girdling. The bark and wood are cut right up to the centre and at times branches are cut into two bits. Girdling is done at any place from 15 cm to 3 meters above the ground.

Management

Hand picking of the adults, from affected plants especially at night with torches and collecting the girdled branches suppresses the pest population.

Spraying infested plants at ground level with any Pyrethroid.

Red Spider Mites



Eggs are laid singly on the underside of the leaf. Each female is capable by laying 60-80 eggs which hatch in 2-3 days. The larval period 10-14 days. Adults lives from 10-20 days. The pest passes through 16 overlapping generation from April to Sep and 4 generation during the rest of year.

Nature of Damage

The mite is active from March to October and passes winter as gravid female. Breeding activities starts as soon as season warm up. It spins web on the under surface of the leaf. All the active stages usually feed on the underside of the leaves. The infected leaf dry up gradually and webbing interferes with plant growth. There is poor setting of the fruits and the yield is considerably reduced.

Management

Pest can be controlled by spraying the crop with Abamectin + Bifenthrin @ 100 ml/ 100 lit of water.

Grape Wasp



Wasps prey on other insects, scavenge food and feed on nectar and the juices of fruit. It has been reported that wasps do not damage fruit themselves but take advantage of injury caused by other insects or birds, diseases such as sour rot, or splitting of fruit. The greatest detriment is from annoyance or injury to pickers. Their stings result in swelling and a painful itch and can trigger severe allergic reactions in some individuals.

Management

Elimination of nests early in the season can be an effective management strategy, but they are often located outside the vineyard or well hidden. Aerial nests in trees can be removed and placed in a plastic bag at night when wasps are inactive. Application of Imidacloprid @ 100 ml/ 100 lit of water.

Thrips



Thrips are very small, elongated and thin insect pests. They are light grey to greenish, but difficult to see.

Nature of Damage

The pest breeds throughout the year except in winter. The adults appear in March and start breeding. Both the adults and nymphs cause damage by sucking cell-sap from the leaves. The pest usually feeds on the under surface of the leaves by rasping the leaf surface with their stylets and sucking the cell sap.

Management

Spraying with Dimethoate/Endosulfan or Nicotine sulphate 0.04% for effectively control the pest. Application of Acephate @ 350 – 400 gm /acre.

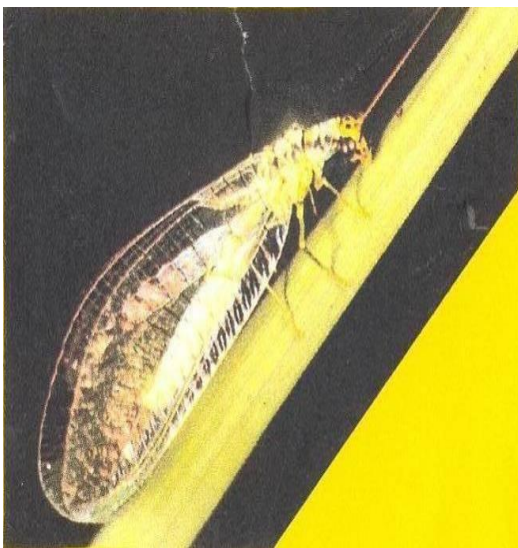
Natural Enemies



Coccinellid adult



Coccinellid larvae



Green lace wing adult



Green lace wing larvae



Aphid parasitoid parasitizing aphids



Mummified aphids



Mummy after parasitoid emergence



Adult parasitoid



White fly adults



Nymphal parasitoid *Eritmocerus*



Parasitizes white fly nymph by *Encarsia*



Encarsia adult



Newly hatched larvae of coccinelids



Coccinelid larvae feeding mealy bug



Coccinelid larvae feeding mealy bug



Coccinelid larvae feeding mealy bug



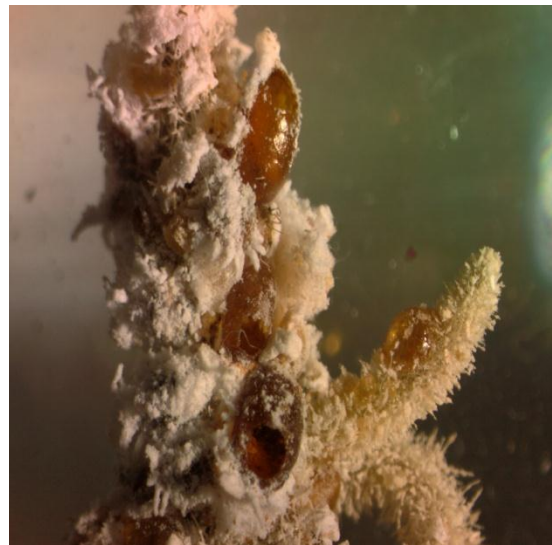
Mealy bug



Aenasius Parasitoid of mealy bug



Aenasius sp parasitizing mealy bug



Pupae of *Aenasius* after emergence



Cotesia larval parasitoid of borers





Parasitizes larvae by *Cotesia*



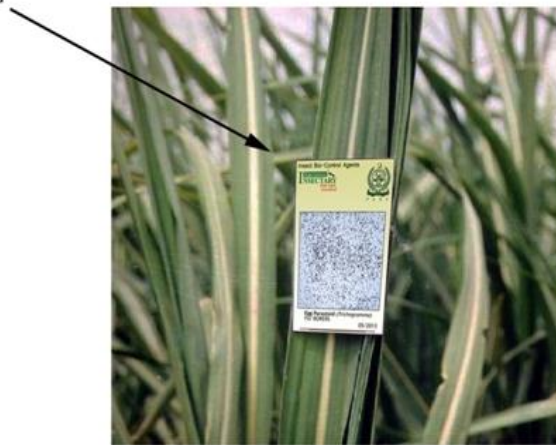
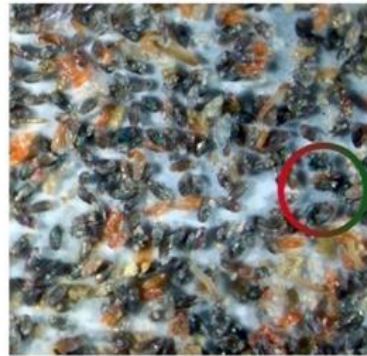
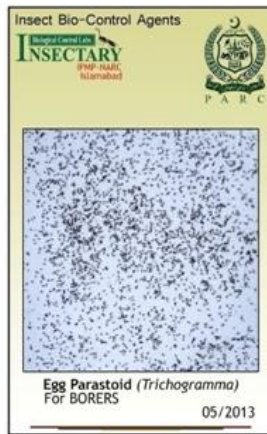
Cotesia making cocoons



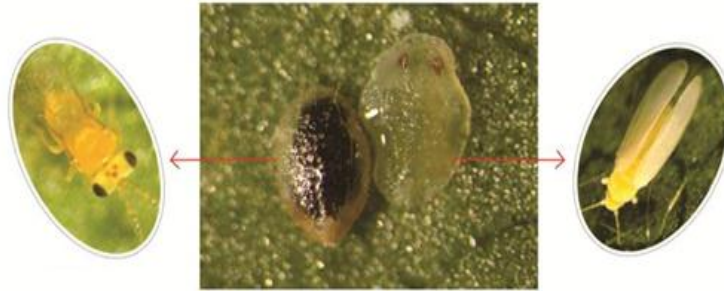
Cotesia adult emerging from cocoons

PEST	    				
	Whitefly	Aphid	Mites	Mealybug	Borers
BIOLOGICAL CONTROL AGENTS	 <i>Encarsia</i>	 <i>Aphidius</i>	 <i>Menochilus sexmaculatus</i>	 <i>Cryptolaemus</i>	 <i>Cotesia</i>
	 <i>Chrysoperla carnea</i>	 <i>Harmonia dimidiata</i>	 <i>Coccinella septumpunctata</i>	 <i>Anasius</i>	 <i>Trichogramma</i>
	 <i>Coccinella septumpunctata</i>	 <i>Coccinella septumpunctata</i>	 <i>Harmonia dimidiata</i>	 <i>Crysoperla carnea</i>	 <i>Crysoperla carnea</i>
	 <i>Menochilus sexmaculatus</i>	 <i>Chrysoperla carnea</i>	 <i>Crysoperla carnea</i>	 <i>Harmonia dimidiata</i>	
	 <i>Harmonia dimidiata</i>	 <i>Hoverfly</i>	 <i>Predatory Mites</i>	 <i>Coccinella septumpunctata</i>	

Bio-Product
Trichogramma (Egg Parasitoid) for Borers



Bio-product
Encarsia cibensis for management
of whitefly reared in Insectary



SAFE AND EFFECTIVE USE OF PESTICIDES

Transport

- Obey laws and regulations
- Keep pesticides away from passengers, livestock and food stuffs
- Load and unload pesticides packages with care
- If spillages or leaks do occur then,
 - Keep peoples and animals away
 - Remove damaged packages and place them on bearer ground, away from dwellings and use soil or saw dust to absorb liquids, sweep up carefully and bury in a place where there is no possibility of contamination of wells and water ways
 - Thoroughly wash down all contaminated parts of the vehicle away from wells and water ways
 - Wear protective clothing during cleanup operation

Storage

- Do not store pesticides with foods and animal feeds
- Store pesticides separately, preferably in a separate building under lock and key, but certainly away from food stuff and other goods
- Never store pesticides for farm use in living quarters. Always keep them in their original containers
- keep them out of the reach of children, preferably locked in a separate cupboard or box
- keep them dry, but away from fires, and out of direct sunlight

Instructions for pesticides use

Always read the label, and seek instruction, before starting to use any pesticides.

In particular check,

- Is the pesticide suitable for the intended purpose?
- What safety precautions need to be observed?
- Measuring and mixing of pesticides
- It is essential to avoid skin contamination, so wear protective clothing as recommended on the product label. If contamination of skin or clothing occurs, wash off immediately, using plenty of water. Splashes in the eyes must be washed out for about 10 minutes.
- Do not measure out or mix pesticides in or near houses or near livestock

- Keep children and animals away

Take care not to contaminate water supplies or puddles from which animals may drink

Use suitable equipment for handling pesticides,

- Measures graduated jugs for liquids, scoops for powders, never use hands as scoop.
- Bucket or open – topped drum, with stick or peddle for mixing. Never dip hands and arms into liquids when stirring.
- Use funnel for using pesticides.
- Use the cleanest available water, filter out debris
- Pour liquids carefully to avoid spillage and splashes - use the funnel if necessary.
- Never suck up any liquid pesticides with a tube
- Wash all equipments after use
- Close up packages after use to prevent leaks or contamination and store safely. Always keep pesticides in their original containers, do not transfer into drink bottles or food containers
- Small quantities of left- over and unwanted concentrates should be tipped into a hole in the ground, away from dwellings, wells and water ways.

Disposal of containers

- Metal cans and drums-wash out, puncture and burry
- Plastic bottles-wash out, puncture and burn or burry
- Card board packaging-burn. Burning must take place away from dwellings and from crops. Do not stand in the smoke of such fire, and keep children away
- Pesticides containers must not be rinsed or washed in streams, rivers or ponds the water used for washing must be tipped into a hole in the ground, away from dwellings, wells, water ways and crops
- If containers can't be disposed of immediately, rinse and stored them securely to prevent theft or misuse, and away from children and animals.
- Do not use pesticide containers for food or drinking water for humans or animals because adequate cleansing is very difficult to achieve. It is everyone's responsibility to discourage this practice

Application equipment-use, maintenance and repairs;

It is the responsibility of all concerned with pesticides use to ensure that peoples engaged in application, weather as sprayers operator or as helpers, are properly trained to achieve good result safely

Owners and operators of machines,

- Clean and check equipment at the end of each day's operations. Pay particular attention to thorough cleaning if the equipment is not used for some time-residual pesticides may cause corrosion and clogging
- Take the most-needed spare parts and tools into the field, so that running repairs can be carried out-such as vehicles, nozzles, hose clips, batteries, spark plugs, screw drivers etc.
- Do not use leaky equipment's - leaks will cause skin contaminating and will result in poor application and may cause crop damage.
- Do not use poor quality equipment-it may be hazardous. Faulty output and poor spraying or dusting patterns will give poor results and may cause damage to crop and be a waste of time and money

Pesticides use in the field

There are many techniques of pesticide use in the field, dependent upon the crop the pest problem and the equipment to be used. There are number of basic principles, common to most situation, which enable users to obtain the most effective results while safe gardening themselves, other people and the environment

- Do not apply pesticide without adequate training
- Never allow children to apply or to be exposed to pesticides, keep them out of areas being treated
- Do not allowed other workers in the field when pesticides being applied
- Read and follow the label instruction or ask for advice regarding dose, technique, protective clothing, timing, repeat applications, and re-entry periods and pre-harvesting intervals
- Take heed of weather conditions, particularly wind, which can cause drift. This may make the pesticide ineffective, by blowing it away from the target, and it may be hazardous if it drifts on to the operator, other crop, water, animals or houses
- Keep people and animals out of freshly treated crops

PRECAUTIONS FOR HANDLING PESTICIDES

Hazards

Pesticides become more hazardous through improper use. Users must be informed and trained to understand the potential hazards of the different products, and the precautions which must be taken to avoid them although the major aim must be to minimize the exposure of humans and domestic animals, pesticides users must also be aware of their responsibility to avoid the contamination of the environment there are three major routes by which pesticides may enter the human body

- Through the skin within (dermal absorption)
- Through the mouth within (oral ingestion)
- Through breathing within (inhalation)

Entry through the mouth can be particularly dangerous, but the precaution to prevent it

- Do not eat, drink or smoke with pesticides - contaminated hands. Always wash hands thoroughly after handling or using pesticides
- Do not store pesticides in drink bottles or food containers. Keep them only in their original containers
- Do not transport or store pesticides with food, so as to avoid contamination.
- Keep pesticides-treated seeds away from food stuffs, to avoid accidental consumption

Environment

Wherever a pesticide is in use, there is a possibility that by accident, carelessness or lack of understanding, some will find its ways outside of the crop or the area that is being treated. The resulting contamination of the environment may be a hazard to wildlife and men. Special risk areas include,

- Wells, ponds, and water courses,
- Cultivated land , where existing or following crops may be contaminated, uncultivated land, supporting wild plants and animals

Protective equipment's

With all pesticides, users must minimize contamination. To prevent skin contamination special clothing should be kept, for use only during mixing and application all clothing must be well washed after every use

Operational precaution

In order to minimize the risks to operators, other peoples and the environment in general, the following rules must be observed,

- Do not work in strong winds
- Work so, that any wind blows the pesticides away from operators, not onto them
- Do not blow out clogged nasals with the mouth-clean them with water or a soft probe, such as a grass stem
- Keep all peoples and animals away
- Never leave pesticides and equipment unattended
- Never leave pesticide containers open
- Collect up all wastes such as empty packages, for safe disposal

Hygiene

Personal hygiene is of the utmost importance for all involved in pesticide application. Operators must be trained to,

- Wash hands and face before eating, drinking or smoking
- Not eat, drink or smoke during work
- Not touch face or other bare skin with soiled gloves or hands
- Wash gloves (if worn) before removal
- Wash thoroughly after work, and launder clothing each day
- Ensure that all the safety precautions on the product label or observed

First aid

Speed is essential in the treatment of any contamination incident to prevent it leading to poisoning specially when a person has been exposed to a highly toxic pesticide, such as where the label carries a skull and cross bones warning in such cases call a doctor immediately or take the patient to the hospital.

- It is easier to prevent poisoning than to treat it, so handle pesticides carefully
- People can be taken ill from natural causes when handling pesticides and it is important to establish that a pesticide is involved before treatment is given. Wrong treatment may make a patient condition worse
- Keeping a patient calm and comfortable and obtaining immediate medical attention will give him the best chance to recover
- If breathing stops, perform artificial respiration immediately

- Remove patient from work loosen clothing around the chest
- Many pesticides can irritate skin and some penetrate rapidly wash splashes of concentrate from skin immediately, preferably with soap and water, but at least with plenty of clean water. Remove contaminated clothing immediately and wash underline skin